WAR AND MODERN SURGERY

By DR. P. MUTO-NARDONE

In every war there are wounded, and in no war have there perhaps been as many wounded as in the present one with its world-wide nature and its weapons of unprecedented efficiency. Has medical science kept up with the intensification of war? A most interesting answer is given in the following article.

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LESS than a hundred years ago, in 1859, during the Battle of Solferino fought between the Franco-Italian and Austrian Armies, all the wounded of both sides were abandoned on the battlefield, without any surgical care. As a consequence, the death rate among these wounded reached ninety per cent.

According to official reports recently issued by the Axis powers as well as by the Allies, out of every hundred wounded on the battlefields of this war, *only two* succumb to the effects of their wounds. This result is entirely due to the high degree of efficiency and perfection attained by modern war surgery.

The vast and bitter experiences acquired in many years of warfare, notably during the Great War and during the Ethiopian and Spanish Wars, have been well recorded, and many new methods of treatment have been developed and improved from these surgical experiences of the past. Moreover, the very methods of warfare have undergone an incessant and progressive transformation, so that war surgery has had to adapt itself to new conditions and circumstances, at the same time maintaining a continuous process of gradual improvement.

The totalitarian character of the present war has enabled the belligerents immediately to mobilize, not only all the surgeons of the respective military corps, but also the best available surgeons from civilian clinics and hospitals. Their skill, coupled with the extraordinary acquisitions and scientific discoveries of the last twenty-five years, has unreservedly and speedily been placed at the disposal of the fighting forces, which thus have been able to profit by the perfect organization of the various Red Cross bodies.

DIFFERENT BULLETS

Nearly all the wounds sustained in the wars of the last century were produced by projectiles from infantry arms, that is, rifle and machine-gun bullets. During the years preceding the Great War, strenuous efforts were made at the International Arms Conferences to introduce a standard projectile of the so-called "humanitarian" type and to have it accepted by the armies of all the world powers. This was the type of rifle and machine-gun bullet meanwhile adopted in theory by all the armies. Consisting of a long, narrow conical body, the bullet, which is made of lead, is enclosed in a jacket made of a copper-nickel alloy so as to avoid deformation.

The wounds produced by these missiles are very different from those produced by the well-known dumdum or expanding bullets, the use of which is prohibited by international law. These bullets were made exclusively of lead, thus very much

resembling the round lead bullets used in the muzzle-loading guns of former days. They were subject to distortion in shape and liable to produce wounds of a serious nature resulting in the destruction of the tissues and consequent infection.

In the Franco-Prussian War of 1870, 90 per cent of the wounds sustained by soldiers of the German Army were caused by rifle bullets of the old type, and the death rate was correspondingly very high. In later wars, owing to the introduction and use of the "humanitarian" type of rifle bullet by both adversaries, fatal casualties and complicated wounds were far fewer.

NEW PROJECTILES

At the beginning of the Great War a very high percentage of wounds was caused by rifle and machine-gun bullets. But suddenly the methods of warfare underwent a great change: shrapnel wounds outnumbered those caused by the "jacketed" bullets, while artillery and airplane high-explosive bombs, together with the splintering hand grenades, began to take the lead. From the statistics of the last three years of the Great War, we learn that only 10 per cent of wounds were caused by rifles and machine guns, while 85 per cent were the result of high-explosive shells and bombs, as well as shrapnel, the remaining 5 per cent being due to various other causes, among them flame throwers, which are being employed in the present war in increasing numbers.

With artillery and aviation missiles assuming a dominating importance, new means of prevention and protection from wounds have rapidly developed in the way of steel or other protective devices for the combatants.

The limited and partial protection of the body by the steel helmet (which in the last war reduced head wounds to a remarkable degree) and the steel vest, extended gradually to a type of integral and collective protection of the entire body of groups of special assault troops, as offered by modern tanks. The size and capacity of these mobile fortresses is continually growing, affording protection to increasing numbers of soldiers.

Even the trench system has been superseded in the present conflict by the introduction of steel casemates, concrete pillboxes, and similar strongholds of a more stable and protective character.

But, notwithstanding these protective measures, both mobile and stable, modern warfare still reaps a great number of casualties, especially after every drive and assault or after aerial bombardments.

NEW WOUNDS

New types of wounds are being caused by the weapons which have suddenly attained such dominating importance. Fragments of high-explosive artillery shells and modern airplane bombs produce frightfully lacerated wounds as well as terrible and widespread mutilations. All the tissues at varying distances and all around the track of the missile are torn in an inconceivable manner, devitalized, and even pulpified by the explosive force of the projectile. The fragments of various forms and sizes, both of the shells and of the bones, drive deep into the tissues and recesses, together with the abraded skin, pieces of dirty, mud-stained clothing, and foreign bodies of all kinds. Needless to say, all these extraneous objects are heavily infected.

In wounds such as we have described above, which often remain in contact with the ground and neglected for several hours or even days, it is not to be wondered at if, in most cases, violent infections develop from pyogenic bacteria or from tetanus and gas-gangrene germs.

WHERE DO THE WOUNDS OCCUR?

A topographical classification of war wounds cannot be made without some difficulty; indeed, in cases which are not particularly rare, multiple wounds are often caused by the explosion of a shell close by, an adjacent burst of shrapnel, or a machine-gun volley. During the Great War, Mussolini received 47 wounds simultaneously from the explosion of a

hand grenade. As many as one hundred wounds have been counted on a combatant during the last war without fatal consequences.

However, the accurate and reliable data of official German statistics show that, out of 13 million combatants of the German Army in the last war, there were 4,800,000 wounded, corresponding to 35 per cent of those engaged at the front. Examining the localization of these wounds, we find that they are grouped as follows :

Localizatiun	*Number*	*Percentage*
Head	693,000	14.0
Neck	72,000	1.5
Spinal column	287,000	5.9
Chest	298,000	6.2
Abdomen	91,000	1.9
Pelvis	115,000	2.4
Upper limbs	1,665,000	33.6
Lower limbs	1,396,000	29.0
Other parts	264,000	5.5

Wounds of the limbs thus total 62.6 per cent. From this figure the truth is apparent—confirmed also by the statistics of other belligerents—that wounds of the extremities are the most prevalent and amount to approximately two thirds of all war wounds.

WHAT WOUNDS TO TREAT FIRST

Precise statistics after the Great War have proved that serious war wounds susceptible to operative cure amount to about 30 per cent of the total. Serious wounds can be divided into two groups : (1) wounds of the head, chest, and abdomen accompanied by lesions of the internal organs, viz., brain, lungs, heart, and intestines; (2) wounds of the limbs with extensive lesions of the bones and joints. According to the most favorable calculations based on the Great War, it was claimed that the mortality rate in the first group amounted to 60 per cent, while that of the second group was 12 per cent.

The practical conclusion of these figures seems to be that the first duty of the surgeon is to devote himself to the serious wounds of the limbs, which can nearly all be cured satisfactorily. This is also in order to prevent serious mutilations and permanent infirmities, which are caused by this category of wounds. Of course, the surgeon must in every case be guided by his judgment and common sense.

Perhaps the most outstanding difference between modern war surgery and that of former days is the modern surgeon's reluctance to amputate. Laney, one of Napoleon's surgeons, boasted after the battle of Moscow of having made two hundred amputations in a single day! Today the maxim is: Never hurry to amputate, there is always time for that. Of course, this does not apply in cases where a limb is almost completely destroyed.

During the emergency period of each "drive" or war action, an enormous number of wounded arrive to overwhelm the dressing stations and field hospitals. It is thus practically impossible to give speedy and effective treatment to all the patients in time. In these circumstances, instead of devoting time and energy on hopeless cases, those wounded which are in the most hopeful condition must be attended to first.

THE TREATMENT OF SHOCK

Shock and hemorrhage are the primary causes for the death of the greatest number of wounded on the battlefield. It has thus become the general rule of war surgery to give absolute precedence to the cure of these serious complications. The very efficacious modern methods which have been devised to combat these complications have resulted in a noteworthy decrease in the mortality rate among war wounded during and immediately after the battle.

Shock is a condition of sudden depression of the nervous system resulting from and occurring after almost every case of war injury. It may vary from a slight temporary faintness to a condition of prolonged depression, and during this state of collapse the vital forces of the body are so exhausted that death may result.

Soldiers wounded in the front line may reach a first-aid post quickly; but they

are sometimes obliged to remain on the battlefield for several hours or days before their removal can be effected, this being done generally at night or when otherwise possible. Loss of blood, exposure to cold, and severe pain generally increase the wound shock.

Today we know what the wounded need in a state of shock. It is essential to apply local and general heat so as to promote warmth of the body, and this by all possible means. On the other hand one must at all costs raise the blood pressure, dangerously low, thus encouraging a better circulation of blood in the vital organs.

The battle against shock caused by severe war wounds or burns has been completely won after the recent discovery of the almost miraculous efficacy of intravenous infusions of concentrated blood plasma. This plasma (or blood serum) is prepared by centrifuging the blood of ordinary donors, thus separating it from the red and white corpuscles and the blood platilets. It can be dried and kept in powder form for an indefinite period and at any temperature. When needed, it is reconstituted by the addition of sterile distilled water or glucose solution. This dried blood can be transported with the greatest ease; and even at the most advanced points of the battle zone it can be prepared for injection and administered *without any regard to its blood group.*

When it is considered that this blood plasma can in some cases be used also as a substitute for ordinary blood in transfusions, it can readily be seen what immense progress has been made in this field in the special and difficult conditions created by war.

STOPPING HEMORRHAGES

The urgent attention devoted by the army surgeon to wounded affected by shock must also be extended simultaneously to those suffering from hemorrhage. The latter is caused by the rupture of blood vessels due to the wounds, and it is from these severed and opened vessels that the patient slowly or rapidly loses all his blood.

Nature endeavors to prevent the loss of blood by its own mechanical means: first, by spontaneous coagulation of the blood and by forming a stopper of coagulated blood which closes the vein or artery; and secondly, by a decrease in the blood pressure, that is, in the power of the heart, which pumps the blood into the blood vessels. The remarkable decrease in the pressure which is present during the "shock" sometimes functions miraculously as a natural phenomenon of autodefenses as a consequence of which many hemorrhages cease spontaneously.

The surgeon, on his part, if he arrives in time, knows all the means available for stopping hemorrhages, even in the most serious cases.

In many cases, however, the wounded soldier arrives at a first-aid station when he has already lost a great deal of blood. In such cases he cannot survive unless he is given the necessary quantity of blood to enable his cells to continue to live. It is in this field that military surgery has made enormous strides.

In former wars many of the wounded died from loss of blood because the easy methods of blood transfusion were unknown. A method often applied was the intravenous injection of normal saline solution, which could serve only as a substitute for quantity but never as a qualitative substitute for blood which had been lost. The result of a timely blood transfusion performed with the safe and simple methods now in practice is in every instance dramatically impressive.

BLOOD TRANSFUSIONS

The first successful transfusion was attempted at Montpellier in 1667 by the surgeon of Louis XIV who gave the blood of a lamb to a fifteen-year-old boy. But it was not until after the discovery of "blood groups" in 1900 that the procedure of using human blood became safe and widespread. Since the Great War, blood transfusions have been commonly practiced.

It is now generally known that human blood can be classified into four groups,

viz., Group A (or II); Group B (or III); Group O (or IV), of general donors; and Group A-B (or I), of general receivers. Every person can give to and receive blood from other persons having blood of the same group. General donors and general receivers can be used as donors or as receivers respectively for all the other groups. Once this law is known and the blood groups of the donor and the receiver have been ascertained, the transfusion can be effected by three methods :

(a) Direct transfusion of the pure and complete blood from the donor to the receiver.

(b) Indirect blood transfusion with blood to which an anticoagulating solution has been added and which can be conserved for a varying length of time.

(c) Transfusion of the plasma (or blood serum) only, as mentioned earlier on.

While the method of direct transfusion can be generally applied in hospitals and clinics with special apparatus, the indirect transfusion of stored whole blood has definitely proved its worth and practicability in war surgery and in the treatment of hemorrhage.

BLOOD FROM CORPSES

From the commencement of the present war, under the incessant and imperative necessity of placing at the disposal of army surgeons great quantities of blood for transfusions, every endeavor has been made to collect as much blood as possible and to preserve it for future use.

Every belligerent army and navy immediately adopted the system of examining the blood of all its servicemen and marking on their disks or, better still, on their bodies by tattooing, the registration of the blood group to which each individual combatant belonged.

Blood for transfusions is also collected from placentas in maternity hospitals. Immediately after the birth of a baby, about 150 cc of blood, which would otherwise be wasted, is drawn off through the navel cord, which connects the baby with the maternal placenta. To this blood, an anticoagulating and preserving substance, such as sodium citrate with glucose and sulfanilamide, is added. The blood is then examined, classified, and placed in cold storage.

Another inexhaustible source of blood which will be used increasingly in the future is corpses. Blood from corpses has been found to be excellent for the purpose, and in Russia such blood transfusions have been made regularly since 1933. There is still a strong prejudice among the majority of people at the thought of transfusing blood from a dead body into a living one. The imperative necessities of this war, however, and the knowledge that the blood of a corpse can be exonerated from the suspicion of disease with much greater certainty, will overcome these prejudices as easily as numerous others that have arisen during the history of surgery.

Whatever its origin, blood for transfusion is carefully examined and classified according to the group to which it belongs. The reactions of Kahn or Kline, more rapid and sensitive than that of Wassermann, are practiced in order to exclude the possibility of syphilis. After the addition of a preserving liquid, the blood is placed in special flasks and kept indefinitely in a refrigerated container.

In the present war, every dressing station and field hospital is kept constantly supplied with classified transfusion blood, these supplies or reservoirs being known as "blood banks." The transfusion of preserved whole blood can be effected instantaneously and in all circumstances, after the choice of groups has been made, by injecting it in the same way as an ordinary intravenous infusion.

INFECTION—DEADLY ENEMY OF THE WOUNDED

In the field of the prevention and cure of infected wounds, war surgery has also made enormous strides. Wounds sustained in the present war, above all those

produced by bomb and shell splinters, can all be considered as potentially infected. The infection is caused either by aerobic bacteria; by pus-producing germs, such as streptococci or staphylococci; or by the deadly anaerobic bacteria of tetanus and gas gangrene.

If the injury is recent, that is, if the wounds are not more than ten or fifteen hours old, the most important and effective treatment consists of meticulous cleanliness and the largest possible excision of all soiled, damaged, and devitalized tissues. After the removal of all these foreign bodies and fragments of bones, the wound can, if not very extensive or associated with serious fracture, be closed.

In wounds which have been sustained more than fifteen hours or so before treatment is available and which are thus suspect of infection, all devitalized tissues are excised, and the injured spot is left open because the pyogenic germs, as well as those of tetanus and gas gangrene, are no longer localized only around the superficial or exposed part but have penetrated deeply into the tissues or blood stream. Local or general infection can in this case almost certainly be expected.

During the Great War, the Dakin method was employed on a vast scale in the treatment of wounds which had already proved infected. This method consists of the continuous or intermittent irrigation of the wound, which must for this purpose be kept wide open, with a solution of hypochloride of soda. By means of pressure, this antiseptic liquid is made to penetrate and flow into the recesses of the wound through a series of rubber tubes provided with numerous orifices. Dakin's solution possesses the properties of dissolving the dead tissues and destroying all the bacteria, bringing about the sterilization of the wounds without any damage to the living tissues. This method has given favorable results.

SULFANILAMIDE AGAIN

The possibility of sure and complete sterilization of wounds by chemical means has been attained only in the last few years with the discovery of sulfanilamide.

From Germany, in February 1935, Gerhard Domagk of the I.G. Farbenindustrie, announced to the world the discovery of a nonpoisonous dye compound called sulfanilamide which, administered orally, had succeeded in absolutely protecting experimental animals against the deadly streptococcus infection. Within a few years, the names prontosil, sulfanilamide, sulfapyridine, sulfathiazol, streptocide, etc., have become household words the world over. They are all derivatives of or compounds similar to the original sulfanilamide and have proved to be reliable remedies of miraculous effect in all streptococcus infections, in erysipelas, puerperal fever, and staphylococcus infections. A host of other ailments such as gonorrhea, pneumonia, and meningitis can be conquered by timely treatment with sulfanilamide products.

In war surgery, too, sulfanilamide has completely revolutionized the technique of the treatment of wounds. Both prevention and cure are now in the hands of the surgeon, since sulfanilamide, administered orally, injected, or even *applied directly* on the wound, absolutely inhibits the life and multiplication of the microorganisms of the infections, and especially of the streptococcus, staphylococcus, or similar germs. Thus such dreaded and often mortal complications of infected war wounds as septicemia and bacterioemia can now be avoided almost with certainty.

PREVENTING TETANUS

Tetanus, commonly known by the name of lockjaw, was the usual complication for soldiers whose deeply lacerated wounds were infected by contact with the earth or by the penetration of dirty pieces of skin and clothing. In the battle of Waterloo, all the wounded infected with tetanus died. In the Franco-Prussian War, the death rate from this infection still exceeded 90 per cent.

At the beginning of the Great War, the pathology of this infection, its course, as well as the method of prevention by

the use of antitetanic serum, were well known. It was also known that the tetanus bacillus is an anaerobic germ, one which can develop only in the depths of the wounds, away from contact with oxygen.

The toxins produced by tetanus rapidly reach the central nervous system by way of the nerves, and the early symptoms are spasms of the facial muscles. The expert eye of the surgeon immediately recognizes the first manifestations of the infection in the wounded by the characteristic expression of *risus sardonicus* on their faces and by the impossibility of opening their mouths (lockjaw). These symptoms are followed by spasmodic contortions and cramps throughout the body; death is rapid and certain, caused by paralysis of the respiratory system and of the heart.

The administration of antitetanic serum is an unfailing antidote which, in the case of infected wounds, at once forestalls all danger of tetanus by the neutralizing effect it has on the toxins.

In spite of the apparent facility of combating this evil, at the beginning of the Great War the armies of the powers involved, as a result of a tragic and inexplicable lack of foresight, found themselves short of the necessary supplies of antitetanic serum. Hence the death rate from tetanic wound infection rose to 70 per cent.

Later came the wise idea of assuming that war wounds were always potentially infected with tetanus bacillus and that the delay in finding out whether any individual case was threatened with infection meant taking too many chances with death. Great quantities of serum were subsequently placed at the disposal of front-line surgeons and, as a rule, every wounded soldier received a preventive antitoxin inoculation at the earliest possible moment. As a result, tetanic infection of wounded had completely disappeared by the end of the Great War.

In the present war, the wounded are given a protective inoculation of concentrated antitetanic serum at the first-aid station; and within seven to ten days another inoculation is administered.

VICTORY OVER GAS GANGRENE

The most dreaded and terrible complication of war wounds is without doubt gas gangrene. During past wars, this form of infection was responsible for a great number of deaths and, above all, for the greater part of the extensive amputations.

Similar to the germs of tetanus, the anaerobic bacteria of gas gangrene live and develop in the recesses and depths of lacerated wounds, beyond contact with atmospheric oxygen. The region infected by gas gangrene swells rapidly, because the germs produce great quantities of gas in the interior of the tissues, above all in the muscles. By developing such a bulge between the tissues, circulation becomes impossible; the blood vessels are choked, and the compressed tissues, deprived of nutrition, die and decompose. Besides this, gas gangrene generally kills the infected wounded by toxemia, and this sometimes occurs within a few hours.

When, as is often the case, gas gangrene localizes in a limb, the surgeon of the past had no other choice but to effect extensive amputation in order to save the life of the wounded. This was the case during the Great War, especially on the battlefields of France, whose manure-infected agricultural soil caused an enormous number of victims.

Studies were immediately undertaken on a large scale which resulted in the discovery of an effective and powerful anti-gas-gangrene serum. This neutralizes the deadly toxins produced by gas-gangrene bacteria and also inhibits the growth of the bacteria themselves. But unfortunately the supplies of this serum were late in forthcoming during the last war, and even then in insufficient quantities.

Now all war surgeons are supplied with adequate quantities of anti-gas-gangrene serum, which is injected prophylactically and therapeutically in large and concentrated doses. In addition, they carry

out the important *early* surgical procedure of cleaning the wound, splitting the tissues, and opening the muscles of the affected limb for a generous length in order to facilitate the escape of gas if already present. Thus even a severe accumulation of gas is prevented from strangulating the circulation.

Among the most amazing and dramatic results, already definitely confirmed by the experiences of this war, is the sulfanilamide therapy of gas gangrene, which has enabled the surgeon to conquer this infection at the very start. Amputation, the only effective weapon at the disposal of surgeons of former times, has been replaced, because of the inestimable action of sulfanilamide and serum, by a less drastic surgery.

As in the case of tetanus, even the dreaded gas gangrene has now become a tragic memory of wars of bygone days.

THE IMPORTANCE OF SPEED

In substance, the whole secret of the success of present-day war surgery consists in the practical application of the principle that, if the wounded are conveniently cleared from the battlefield and treated within the first eight or ten hours of their injuries, the beginning or progress of any infection or complications can be definitely prevented. This knowledge has led to a realization of the supreme importance of effecting the earliest possible removal of the wounded from the battle line to the highly organized modern dressing stations and field hospitals.

The latest means of transportation with mechanized vehicles and even planes have contributed enormously to the proper and timely treatment of the wounded. At the modern field hospitals, now generally situated close to the battle line, every emergency operation and even major operations can be performed, while the latest methods of treating wounds and fractures can be swiftly applied.

Where fighting takes place overseas, hospital ships in great numbers are operated between clearing stations overseas and hospitals at home. Their facilities, organization, and staffs are equal to the best. During the Abyssinian campaign, Italy became the first country at war to possess a modern regular fleet of hospital ships; thirty most up-to-date vessels of this type operated between Italy and East Africa, all equipped with air-cooling systems.

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Thus present-day war surgery in its work of mercy has managed to keep up with the terrific tempo of a modern war of movement, and the number of killed and of those maimed for life, in comparison to the vast quantities of troops employed, has dropped dramatically to a point far below that of former wars.